

EMBEDDED DIAGNOSTICS AND PROGNOSTICS SYNCHRONIZATION

Dr. Miranda M. Keeney, Russel E. Rhoads, and Charles D. Taylor

Introduction

The Army vision for the 21st century is a rapidly deployable, highly mobile fighting force with the lethality and survivability needed to achieve a decisive victory against any adversary. To support this vision, the Army's logistics system must be versatile, agile, sustainable, and affordable. Army transformation is bringing about these fundamental changes in the Army's structure, equipment, and doctrine. Additionally, while the Army's science and technology, research and development, and procurement investments are focused on creating and fielding the Objective Force in the next 10 to 15 years, selected portions of the Legacy Force are being recapitalized to bridge the gap between today's Army and the Objective Force. The responsibility for sustaining today's force and the transforming Army is the business of the Deputy Chief of Staff, G-4 (DCS, G-4) (Logistics), who is also responsible for managing the Army's logistics footprint.

The Logistics Footprint

One of the Army's transformation goals is to reduce the logistics footprint of combat support and combat service support while enhancing the

sustainability, deployability, readiness, and reliability of military systems. This requires new logistics processes and dramatic changes in current business processes to support the new force. These processes are focused on weapon systems and must be readiness-driven, lean, and agile. They must detect and correct problems early, allocate resources where they are most needed, and continuously reduce labor requirements and cost. One of the key enablers for the objective sustainment processes is to equip platforms with self-reporting, real-time embedded diagnostic and prognostic systems. This enabler promises to replace entire segments of the traditional logistics support structure. Such systems would contribute directly to the following key objectives for the future Army:

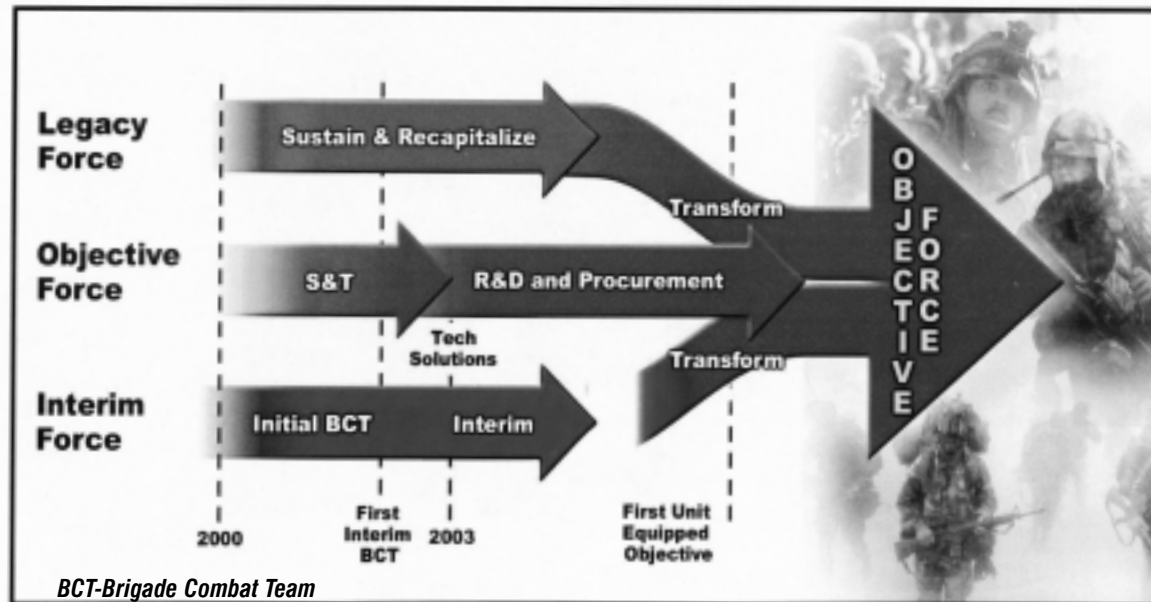
- Virtual logistics situational awareness at all levels,
- Proactive (versus reactive) combat logistics,
- Improved readiness for weapon platforms and support equipment,
- Reduced logistics footprint on the battlefield,
- More effective fleet management and reduced life-cycle costs, and

- Reduced logistics workload on the warfighter and crews.

Adding embedded diagnostics and prognostics capabilities to equipment and developing the infrastructure to generate maximum benefit from the prognostics data is a major challenge. The infrastructure needed to transmit, store, and use the information is complex, requiring changes to many existing and emerging communication and information systems. The potential application to thousands of Army platforms includes vehicles, aircraft, and marine craft. Therefore, an implementation strategy is needed that achieves maximum benefit with the resources available, recognizing that technology is continuously evolving. This strategy should answer the following questions:

- When, where, and how much diagnostics and prognostics capability should be developed and installed?
- What communications medium will be used to move the information?
- What technology do users need to move or use the information or data?

Sustaining the TRANSFORMING Army



Responsive, Deployable, Agile, Versatile, Lethal, Survivable, Sustainable

- What policy and doctrine additions or changes will be required to support the Interim and Objective Forces?

- What requirements documents will be impacted?

- What are the funding implications related to the Program Objective Memorandum (POM)?

The Army leadership recognizes the importance of diagnostics and prognostics as transformation enablers and has directed that these enablers be considered for use on new and retrofitted equipment for several years. Unfortunately, funding limitations and detailed requirement specifications have delayed and inhibited their development and integration. However, changing operational concepts and emerging Objective Force requirements now make integration of these enablers a

necessity. Furthermore, the application of these enablers is expected to contribute significantly to the Army's logistics transformation by improving the Army's supply chain management of consumables, repairables, and the end items themselves.

Synchronization

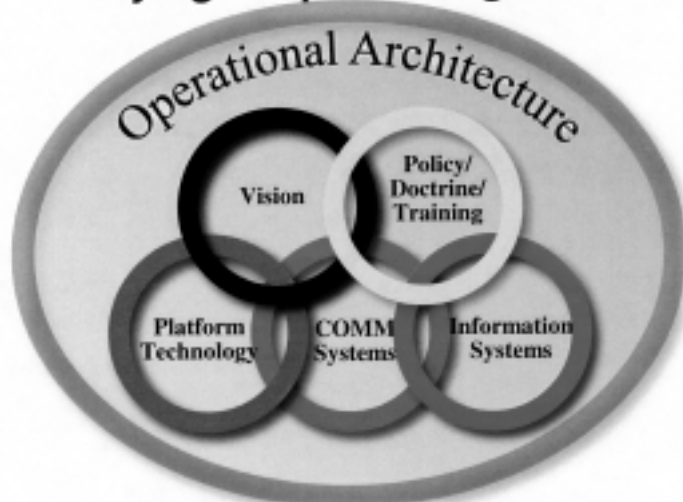
There is a need to apply these embedded diagnostic and prognostic capabilities across the entire Army, employing communication systems and modifying information systems to make use of the new sources of information. The Army's diagnostics and prognostics community of combat developers, materiel developers, and logisticians has been working to achieve the Army Chief of Staff's goal of putting embedded diagnostics and prognostics on all weapon systems. This requires those systems that have historically been developed inde-

pendently to be synchronized to support an overall system-of-systems. Subsequently, the DCS, G-4 directed the U.S. Army Logistics Integration Agency (LIA), the Army's integrator of logistics systems and processes, to coordinate and synchronize these efforts under a project called Embedded Diagnostics and Prognostics Synchronization (EDAPS).

The EDAPS project is an overarching process that coordinates a unified Army strategy synchronizing the Army's current diagnostic and prognostic initiatives. The G-4 tasking calls for the LIA to pull together all the key diagnostic and prognostic players from across the Army and develop an end state that considers all the current diagnostic and prognostic pilots, programs, and plans and integrates the current programs and initiatives. The EDAPS project objectives include the following:

Embedded Diagnostics and Prognostics Synchronization ...

Tying the pieces together



An overarching process to direct and coordinate a unified Army strategy with respect to embedded diagnostics and prognostics

- Identify Interim and Objective Force business processes;
- Influence the requirements of future operational and management systems such as the Global Combat Support System-Army, Wholesale Logistics Modernization Program, and the Future Combat Systems;
- Influence the requirements of weapon system platforms;
- Determine the best return on investments;
- Identify data requirements at all echelons;
- Identify policy and programmatic gaps and redundancies and define, and then re-engineer the operational architecture and its business processes from the platform, through retail, into the wholesale system; and
- Identify POM issues.

The project's scope of work includes the legacy fleets and the transformation to the Objective

Force as outlined in emerging Army doctrine and Joint Vision 2020.

The LIA established a synchronization integrated product team (IPT) consisting of representatives from the Army's diagnostics and prognostics community. The team's first order of business was to define the operational architecture, develop a management structure that involved users at all stages of development to ensure coordination and integration, and establish a common vision for the logistics embedded diagnostic and prognostic processes.

The team's operational architecture will define the vision and identify requirements for policy, doctrine, and training; platform technology; communication systems; and information systems as the key pieces that need coordination and synchronization. An enterprise management framework approach was selected as the proposed management structure to ensure that all aspects of the oper-

ational architecture are considered. The approach is designed to engage key players in the information collection and analysis process and to build consensus for the path forward to the maximum extent possible. It also maximizes EDAPS' probability of success based on the complexity of the G-4 tasking.

The EDAPS team is synchronizing and coordinating Army diagnostic and prognostic issues across the entire business enterprise for the entire weapon system's life cycle, not just at the platform level. This includes a review of Army policy and regulations and in-depth assessments of related initiatives.

Requirements for embedded diagnostics and prognostics are being added where appropriate to Army operational requirements documents based on the EDAPS team's input. Finally, a collaborative framework of interrelated working groups, coordinated through a synchronization IPT, has been created to facilitate the process and manage the total enterprise. In this manner, a means has been made available for synchronizing policy, procedures, operations, doctrine, training, and automation requirements.

The supporting teams build on the work of the Army Diagnostics Improvement Program, which complements efforts focused on incorporating diagnostic sensors and read-out mechanisms for Army weapon systems. The EDAPS process is expected to identify and document EDAPS' end-to-end information requirements (including tactical, nontactical, and strategic) for all users and develop a road map to describe how these requirements should be developed to support near-term, interim, and objective forces. It will also identify tactical, nontactical, operational, and strategic communication requirements that are primarily driven to address the information requirements for all

levels of field, depot, and national management activities. Finally, EDAPS will refine and define policy, doctrine, and operational architectures to ensure that all future requirements are reflected in appropriate policy, doctrine, procedures, automation, and training.

The synchronization IPT is responsible for assuring that the other working groups address the comprehensive breadth and depth of the issues involved in implementing embedded diagnostics, condition-based maintenance, and the linkages between these processes and relevant field, depot, and national information systems.

Summary

The coordination and synchronization of embedded diagnostics and prognostics for the Objective Force is critical to Army transformation because this technology impacts logistics operations at all levels—from maintainers to life-cycle managers. A wide range of Army organizations responsible for the doctrine, policy, equipment, training, funding, business processes, information sys-

tems, and communication systems will be affected by this technology.

It will take many years and substantial investments to fully implement the Army's vision for self-reporting weapon platforms and support vehicles with embedded diagnostic and prognostic capabilities. The project's development of a comprehensive operational architecture for generating, capturing, moving, storing, and using platform-based readiness information will greatly facilitate development of the common vision for platform-focused logistics processes.

Significant work remains to be done to develop a robust logistics system around this technology. Synchronizing these efforts is a major challenge. Although the DCS, G-4 tasked LIA to lead the synchronization effort, it is clear that this undertaking will be successful only if affected organizations are directly involved in defining the end state and developing the implementation road map. The EDAPS process allows for this coordination and synchronization to achieve the Army's vision of embedded diagnostics and prognostics in support of the Objective

Force and will ensure that the process is institutionalized.

For more information about EDAPS, please visit the LIA home page at <http://www.lia.army.mil>.

DR. MIRANDA M. KEENEY is a Strategic Logistics Program Specialist in the Materiel Logistics Division of LIA and the Project Leader for the EDAPS Program. She holds a Ph.D. in industrial engineering and an M.S. in operations research from Penn State University. A graduate of the U.S. Army War College, she served there for a year as a Visiting Professor for artificial intelligence.

RUSSEL E. RHOADS is a Senior Program Manager with the Pacific Northwest National Laboratory working on the Army's EDAPS Program. He has a B.S. in physics and an M.S. in nuclear engineering from the University of Washington. For the past 15 years, he has led and contributed to programs helping DOD organizations modernize logistics systems and develop strategies for configuring, modernizing, and managing industrial operations.

CHARLES D. TAYLOR is a Logistics Management Specialist in the Materiel Logistics Division of LIA. He holds a B.A. from the University of Pittsburgh. Taylor is also a graduate of the DARCOM (now the Army Materiel Command) Intern Training Center's Materiel Maintenance Management Program and the Army Logistics Management College's Logistics Executive Development Course.

*The coordination and synchronization
of embedded diagnostics and prognostics
for the Objective Force
is critical to Army transformation
because this technology
impacts logistics operations
at all levels—from maintainers
to life-cycle managers.*